Background Information to Assist Industry in the Development of Product Standards or Guidelines for Cultured Sunray Venus Clams

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Funded by the Florida Sea Grant College Program

Draft Version: November 2012

The sunray venus clam *Macrocallista nimbosa* is a large attractive clam distributed from North Carolina to Florida and the Gulf of Mexico states. During the 1960-70s, these clams were commercially harvested off the northwest Florida coast. Although natural growth rates were estimated to be high, its patchy distribution limited commercial exploitation. The prior fishery and existence of a latent market, along with it being a native species, made the sunray venus clam a logical choice as a candidate species to expand the shellfish aquaculture industry in Florida, which is based on the northern hard clam *Mercenaria mercenaria*.

Over the past six years, research and extension faculty at the University of Florida and Harbor Branch Oceanographic Institute at Florida Atlantic University, along with industry partners, have evaluated the aquaculture and market potential of the sunray venus clam with funding through the Florida Sea Grant College Program. Information obtained from growout trials, consumer acceptance studies, wholesale market surveys, sensory characterization, and other work have been compiled here to develop product standards or guidelines for the industry to use in harvesting, handling, processing, and distributing cultured sunray venus clams.

Harvest Sizes

The sunray venus clam is oblong in shape, whereas the hard clam is round. Thus, harvest sizes of the sunray venus will differ from those typical for the hard clam. Further, harvest size must take into consideration that meat weight and meat fill of the sunray venus is higher than a similar sized hard clam.

Shell Length and Width Relative to Commercial Grades

Since sunray venus clams differ in shape from hard clams, relationships between shell width (SW) and shell length (SL) were quantified using data (n = 3,020) obtained from harvests of field trials. The data were plotted and then analyzed by regression ($R^2 = 0.7406$). A power function ($y = 0.6792x^{0.866}$) was determined to best fit the data. In Figure 1, horizontal lines represent commercial grades in SW used by the hard clam industry and vertical lines represent the associated average SL calculated using the power function derived from the regression.

The shell length to width relationship of potential commercial grades for cultured sunray venus clams is summarized in Table 1. In general, the average SL:SW ratio for sunray venus clams is 2.5; whereas for hard clams, it is typically around 2.0. When examining ratios associated with

commercial grades ranging from 16 mm (5/8") to 28 mm (1 1/8"), SL:SW ratios increase from 2.4 to 2.6.

Figure 1. The relationship between shell width (mm) and shell length (mm) was derived from harvests of cultured sunray venus clams (n=3,002) in field trials. Values associated with potential commercial grade sizes were determined from a formula produced by a regression of the plotted data.

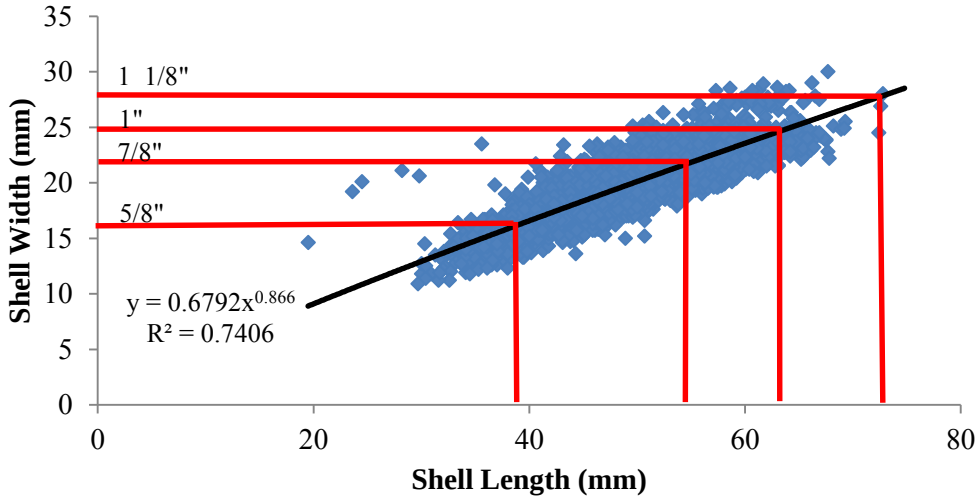

Table 1. The relationship between potential commercial grades in shell width and shell length of cultured sunray venus clams was determined by the regression of plotted data in Figure 1.

Grade (in)	Grade (mm)	SL (in)	SL (mm)	SL:SW
5/8	16	1.5	38.4	2.4
7/8	22	2.2	55.5	2.5
1	25	2.6	64.3	2.6
1 1/8	28	2.9	73.3	2.6

Weight Relationships

Since differences exist between sunray venus and hard clams of the same grade or SW, wet meat weight (MW) and meat fill must also be considered when determining harvest sizes for sunray venus clams. Shell width (SW), MW, and total weight (TW) data were obtained from harvests for sunray venus (n = 266) and hard clams (n = 384). Regression analyses were performed for TW and MW against SW for both clam species.

The relationships between weight and shell width are presented in Figure 2 for the sunray venus clam and in Figure 3 for the hard clam. For both, a power function best fit the data. The power function generated for each species was used to calculate TW and MW for commercial grades of the sunray venus clam (Table 2) and the hard clam (Table 3). When comparing TW and MW of sunray venus clams to hard clams, several trends emerge. First, both clams have similar TW relative to SW or grade. Second, the meat weights (MWs) of sunray venus clams are approximately twice the MWs of hard clams for a given grade.

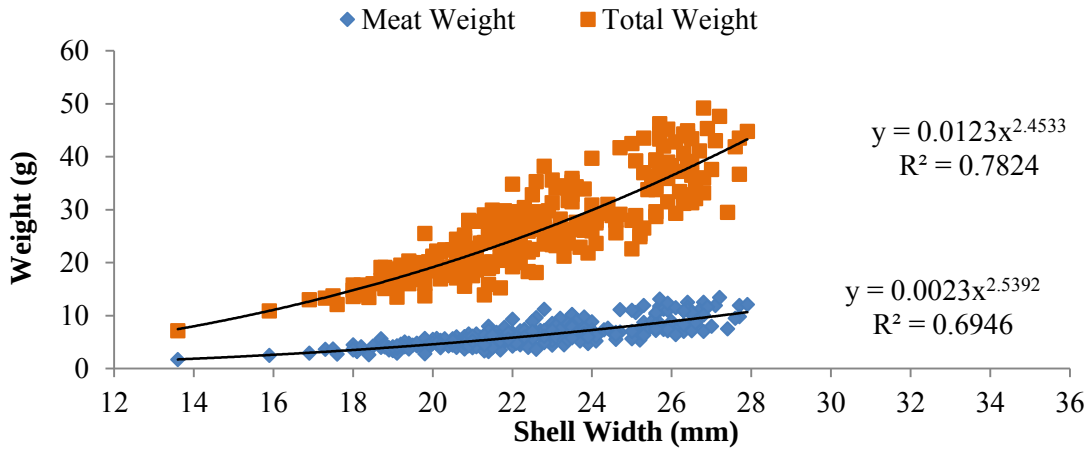

Figure 2. The relationship between weight (meat and total) and shell width in cultured sunray venus clams (n = 266) was calculated using a regression of harvest data.

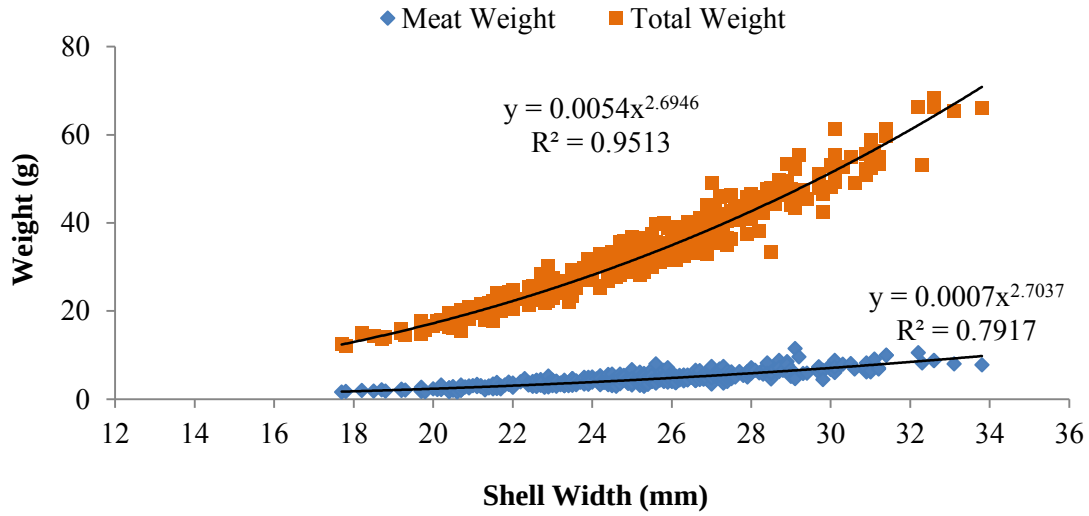

Figure 3. The relationship between weight (meat and total) and shell width in cultured hard clams (n = 384) was calculated using a regression of harvest data.

Table 2. Meat weight (MW) and total weight (TW) of cultured sunray venus clams are compared by potential commercial grades, or shell width (SW). Values for MW and TW were derived from a regression of the plotted data in Figure 2.

Grade	MW (g)	TW (g)	MW:TW	MW:Grade	TW:Grade
16 mm (5/8")	2.6	11.1	0.24	0.16	0.74
22 mm (7/8")	5.9	24.2	0.24	0.27	1.21
25 mm (1")	8.2	33.1	0.25	0.33	1.32
28 mm (1 1/8")	10.9	43.7	0.25	0.39	1.56

Table 3. Meat weight (MW) and meat weight (TW) of cultured hard clams are compared by commercial grades, or shell width (SW). Values for MW and TW were derived from a regression of the plotted data in Figure 3.

Grade	MW (g)	TW (g)	MW:TW	MW:Grade	TW:Grade
16 mm (5/8")	1.3	9.5	0.13	0.08	0.63
22 mm (7/8")	3.0	22.4	0.13	0.14	1.12
25 mm (1")	4.2	31.6	0.13	0.17	1.26
28 mm (1 1/8")	5.7	42.8	0.13	0.20	1.53

Third, the ratio of MW:TW indicates that MW comprises 25% of the TW for sunray venus clams; whereas MW comprises only 13% of the TW for hard clams. Lastly, growth based on TW:Grade is comparable between the two clam species; but, the ratio of MW:Grade is almost 100% greater by grade for the sunray venus clams.

The morphological characteristics of cultured sunray venus clams and hard clams for the commercial grades of 22 mm, or 7/8" SW, and 25 mm, or 1" SW, derived from these datasets are summarized in Table 4. Average TW of both clams is similar. However, the SL of 7/8"-graded sunray venus clams is 29%, or 13.0 mm (0.6"), greater than the SL of hard clam of the same grade. The MW of 7/8"-graded sunray venus clams is 72%, or 2.8 g, greater than the MW of hard clams. Furthermore, the SL of 1"-graded sunray venus clams is 32%, or 15.6 mm (0.6"), greater than the SL of hard clams of the same grade. The MW of 1"-graded sunray venus clams is 88%, or 4.4 g, greater than the MW of hard clams.

Table 4. Two potential commercial sizes (7/8" and 1" in shell width) of cultured sunray venus clams reared in field trials are compared with the northern hard clam.

Clam Species	Grade	Shell Width	Shell Length	Meat Weight (wet)	Total Weight
Sunray venus (n=80)	22 mm (7/8")	23.1 mm (0.9")	57.9 mm (2.3")	6.7 g	27.7 g (16/lb)
Hard clam (n=117)	22 mm (7/8")	23.6 mm (0.9")	44.9 mm (1.8")	3.9 g	27.4 g (17/lb)
Sunray venus (n=62)	25 mm (1")	26.1 mm (1")	64.5 mm (2.6")	9.4 g	37.3 g (12/lb)
Hard clam (n=142)	25 mm (1")	26.3 mm (1")	48.9 mm (2.0")	5.0 g	36.2 g (13/lb)

Wholesale Market Surveys

Surveys, along with samples of cultured sunray venus clams, were sent to shellfish buyers (n=33), comprised of wholesalers, brokers, or distributors, to assess product attributes. These firms were also asked to share their views and those of their customers regarding potential sunray venus clam marketability and demand. Most expressed a favorable impression of sunray venus clams, ranking them above average in almost every category, including shell appearance, meat color, taste, texture, and yield. Fifty-six percent of the respondents indicated that meat

yield was as expected, while 44% suggested that meat yield was greater than expected. Favorable comments included that sunray venus clams were "plump with good meat-fill, full meat content, and good yield after cooking filling the whole shell."

Shell Appearance and Coloration

In a consumer acceptance study conducted at four restaurants during 2008, patrons were asked to share their opinions of sunray venus clams. Eighty-four percent of respondents (n=239) indicated that the appearance was "Excellent," whereas 13% indicated that the product was "Very Good." Shellfish wholesale distributors (n=33) responding to a product attribute survey in 2010-11 also ranked the appearance of sunray venus clams very high (7.3 on a scale from 1 to 8). Comments were positive and included favorable responses, such as "nice, attractive, beautiful, and unique appearance, colorful and different shape than average clam, and nice color before and after cooking." Shell coloration after cooking is also an attractive characteristic associated with sunray venus clams. Seventy-five percent (24 out of 32) of the shellfish wholesalers participating in the product survey noted that the shell color changed when cooked. Shells turn from gray/brown in color to a peach/orange tone when subjected to heat (Figure 4). This is possibly due to the presence of carotenoids in the periostracum (shell lining) protein matrix that change color when heat is applied.

Shell color was also evaluated by the trained seafood sensory panelists at the UF Aquatic Food Products Lab during the summer of 2010. In describing, or profiling, the sunray venus clam, panelists were asked to characterize raw shell color. The grayish-brownish tones of the uncooked shell turn these colors when heated. The cooked shell should be very appealing to consumers and can be used in attractive plate presentations or displays.
Gray totaled the highest number of responses (4 out of 9), followed by brown, and light brown (2 responses for each). Over 50% (6 out of 11) of responses characterized cooked sunray venus shell as peach in color. Panelists during the winter 2011 trials responded that raw clam shell color was gray (50% of responses) or some shade of brown (17% for brown and 25% for light brown). Cooked shell results were variable as all colors (peach, gray, orange, brown) had a similar number of responses. The color change, along with a radiating pattern on the glossy-smooth shell described in the sensory profile evaluations and multiple surveys, should be appealing to consumers and can be used in eye-catching plate presentations.

Figure 4. The shell color of sunray venus clams range from gray to brown (right). After cooking, the shell color of sunray venus clams changes to peach and orange color tones (left).

Other Product Attributes

In addition to shell appearance and color, the trained seafood sensory panelists at the University of Florida's Aquatic Food Products Lab conducted a sensory evaluation of the sunray venus clam to describe, or profile, the characteristics of this new aquacultured clam (Table 5). The edible meat is lighter in color, varying from white, cream to light yellow (Figure 5). The attractive meat colors could also be used in marketing efforts to embellish the product. The plumpness and volume (e.g., an almost full half-shell) of the meat can be used to distinguish the sunray venus clam since the ratings were very high for these two attributes. In terms of taste, ratings for "salty" were a very distinguishing attribute. This result is not unexpected since clams are filter-feeders and this clam is cultured in high salinity waters. The salty flavor would not necessarily distinguish clams from a region, but could reflect seasons and local weather conditions. Also, there is an interesting range in the ratings for umami basic taste, which has not been previously described for hard clams. Umami is a term borrowed from the Japanese, meaning "good flavor" or "good taste". Scientists describe this fifth basic taste as brothy, meaty, or savory. This could be another attractive term used in marketing to describe the sunray venus clam. In addition, the sunray venus clam has a distinguishable seaweed and metallic-like flavor, similar to chicken liver, and the light meat texture is very firm.

Table 5. Sensory profile for the meat of cultured sunray venus clams.

Appearance	Very plump, fully covered clams, predominantly light color meat
Aroma	Moderate briny and metallic aroma
Basic Flavors	Salty, with moderate umami
Flavors and Aftertastes	Seaweed was the predominant flavor accompanied by strong metallic
Textures	Firm texture

Figure 5. The edible meat of cultured sunray venus clams is light in color, varying from white, cream to light yellow. The plumpness and volume (e.g., an almost full half-shell) of the meat can be used to distinguish sunray venus clams.

Purging to Remove Grit

According to a NOAA (no date) report, one of the attributes of sunray venus clam meat was that it was "grit-free." However, in the UF studies as well as observations of others (e.g., Stokes et al., 1968), grittiness can be problematic in cultured sunray venus clams. Two sources of grit may be found. The first source of grit is commonly found in filter-feeding, infaunal (bottom-dwelling) bivalves. It is associated with materials (e.g., sand, sediments) found in the mantle or shell cavity of the animal, typically accumulated during the harvest process. The second source, which is referred to as a "grit pocket," holds deposits known as renal calculi, or kidney stones. These are composed of calcium phosphate and may range in size from <0.1 to 2.5 mm (Tiffany III, 1979). The grit pocket can be observed as a dark mass in the dorsal portion of the meat near the kidney and siphon retractor muscle (Figure 6). Renal calculi are found in all stages of the life history of the sunray venus clam, although no known reason has been given for the existence of this physiological adaptation. The individual stones continue to grow and aggregate until harvest or death (Tiffany III et al., 1980).

Figure 6. Internal anatomy of a sunray venus clam with an arrow pointing to the grit pocket.

During the 2006-08 field trials conducted by UF, 10 sunray clams of nursery seed size (~8-10 mm SL) were examined histologically for any sign of renal calculosis, or "grit pocket"; but, no signs were evident. Tiffany (1979) indicated that all animals he tested were greater than 1 year of age. Therefore, this may not form or be noticeable until a certain life stage or age. The age of cultured sunray venus clams at harvest may range from 18 to 24 months, depending on the targeted market size and culture conditions. To evaluate the efficacy of purging harvested sunray venus clams in reducing the grit pocket size and presence, sunray venus clams were placed in tanks with running saltwater (the water source was from conditionally approved shellfish harvesting waters) for seven days post-harvest. Fifteen sunray venus clams were collected at one, three, and seven days post-harvest and measured for morphological (shell width, shell length, total weight, and meat weight) and grit pocket characteristics (height, length, area, and weight). An analysis of variance was performed to identify statistical differences ($p < 0.05$) between parameters for sunray venus clams collected on different days post-harvest. Morphological characteristics (values ranging from 23.7 to 24.4 mm SW, 57.2 to 58.8 mm SL, 29.6 to 31.9 g TW, and 5.19 to 6.05 g MW) were statistically similar ($p > 0.05$) for the three post-harvest samples (Table 6). Although statistical differences did exist for grit pocket height ($p = 0.007$), no significant variation was detected for grit pocket length ($p = 0.4291$, values

ranging from 6.51 to 7.00 mm), grit pocket area ($p = 0.0657$, values ranging from 39.7 to 48.1 mm^2), or grit pocket weight ($p = 0.3182$, values ranging from 0.167 to 0.200 g). Grit pocket height was statistically similar for clams measured on days one (6.05 ± 0.69 mm) and three (5.97 ± 0.68 mm), but by day seven grit pocket height (6.83 ± 0.94 mm) was significantly higher from the two previous days. This could be associated with a different sized sample of sunray venus clams collected on day 7 as compared to those collected on days 1 and 3 post-harvest. Although the grit pocket size did not diminish over time due to purging, average grit pocket weight for the three sampling days amounted to only 3.3% of the total weight of sunray venus clams.

Table 6. Means and standard deviations (SD) of the morphological characteristics of cultured sunray venus clams and grit pocket measurements during a purging study conducted in 2010.

Days Post-Harvest	Shell Width (mm±SD)	Shell Length (mm±SD)	Total Weight (g±SD)	Wet Meat Weight (g±SD)	Grit Pocket Height (mm±SD)	Grit Pocket Length (mm±SD)	Grit Pocket Area (mm^2±SD)	Grit Pocket Weight (g±SD)
1	23.7 ± 2.3 [a]	57.2 ± 5.6 [a]	29.6 ± 6.7 [a]	5.19 ± 1.54 [a]	6.05 ± 0.69 [b]	6.51 ± 1.16 [a]	39.7 ± 9.8 [a]	0.167 ± 0.062 [a]
3	24.4 ± 1.4 [a]	58.4 ± 3.0 [a]	31.3 ± 3.5 [a]	5.53 ± 0.84 [a]	5.97 ± 0.68 [b]	6.89 ± 1.11 [a]	41.3 ± 9.2 [a]	0.200 ± 0.053 [a]
7	24.4 ± 1.8 [a]	58.8 ± 5.3 [a]	31.9 ± 7.3 [a]	6.05 ± 1.57 [a]	6.83 ± 0.94 [a]	7.00 ± 0.91 [a]	48.1 ± 11.4 [a]	0.187 ± 0.064 [a]

Different superscript letters following SD denote significant differences ($p < 0.05$) between means.

Through the use of consumer acceptance studies and wholesaler surveys, the "grittiness" of cultured sunray venus clams was assessed. Of restaurant patrons surveyed (n=239), who consumed cooked sunray venus clams, only 11% found the meats to be gritty. Of sushi restaurant patrons surveyed (n=101), who consumed raw sunray venus clams that were larger than those provided in the prior study, 19% reported some grit. Of shellfish wholesalers surveyed (n=33), 50% detected no grit at all in samples, 46.7% detected some grit, and 3.3% (or one respondent) reported excessive grit. In sensory profile evaluations conducted at the UF Aquatic Food Products Lab in the winter of 2011, the mean rank for grittiness did not exceed 3.1 in raw sunray venus clams and 2.8 in cooked sunray venus clams, based on a scale of 1-10. Values obtained during evaluations conducted in the summer of 2010 were lower for both raw (0.4) and cooked (0. 6) clams, indicating varying conditions during harvest or possibly seasonal variability. Average SL of cultured sunray venus clams used in the winter evaluation was 54 mm, or 2.2"; SL measurements ranged from 50 to 55 mm (2-2.2") for survey venus clams used in the summer evaluation.

Purging clams to remove grit is a choice made by the harvester and/or wholesaler based on the demands of the buyer. Most clams, including the hard clam, can easily be purged using simple methods, such as keeping the harvested clams above the substrate at the harvest site for several hours. During the harvest of sunray venus clams in field trials, it has been noted on several occasions that the sunray venus clams contained a large amount of grit (sand or sediment) in the shell cavity, especially if the harvest waters were turbid due to wind conditions. The sunray venus clam has fused siphons, which are much longer than a hard clam and may have a higher filtering capacity. Therefore, it is highly recommended that sunray venus clams are purged on the lease for an adequate time to allow possible grit to be reduced and/or eliminated prior to

delivering the product to the shellfish wholesaler. This may also be accomplished post-harvest at the processing plant by a process known as wet storage. However, this process is a more expensive option, which also must be approved through the Florida Department of Agriculture and Consumer Services, Division of Aquaculture.

Handling

Although sunray venus clams have thinner shells (24.9 g mean shell weight for a 1" grade derived from Table 2) than hard clams (27.4 g mean shell weight of a 1" grade derived from Table 3), they are still able to withstand handling associated with processing activities (e.g., tumbling and grading) with minimal shell damage. During tumbling of approximately 1,400 cultured sunray venus clams, only 12, or less than 1%, were damaged. In another evaluation, only 22 of 1,100 sunray venus clams, or 2%, were broken during tumbling. An alternative method of handling during grading was also examined (Figure 7). Graded sunray venus clams were collected in harvest bags that were submerged in a five-gallon bucket of water and was compared with the typical industry protocol. In both instances, minimal chipping and breakage of sunray venus clam shells was noted. For harvest bags submerged in water, only three of the 575 sunray venus clam shells, or less than 1%, were damaged as compared to two of the 575 shells that were damaged in the control method. These data suggest sunray venus clams can withstand commercial handling; but, it is strongly recommended that these clams be handled with more care than hard clams.

Figure 7. Sorting potential commercial sizes of cultured sunray venus clams on a grader.

Shelf Life

Molluscan shellfish are typically shipped live; therefore, adequate shelf life is an important product attribute. For mollusks, shelf life is the time from when the clams are harvested from the water until they are no longer fit to eat. Federal and state regulations require that live mollusks be placed in refrigerated storage within a predetermined time/temperature matrix to minimize probable levels of *Vibrio* bacteria (FDA 2005).

Wholesale Market Surveys

Shelf life of sunray venus clams was gauged by wholesalers, who were shipped cultured samples from November 2010 through May 2011. Twenty-eight (90.3%) of thirty-one respondents indicated that shelf life was acceptable. Three responses, which indicated that shelf life was unacceptable, were associated with sunray venus shipped in November, when water temperatures were cooler. One respondent indicated that three days after receiving sunray venus clams, 30 had died and one "mudder" was present. Another participant indicated that gaping in retail showcases after a short time was a problem.

Sensory Profile Evaluations

Summer and winter-collected samples of sunray venus clams were used to discern the influence of water temperatures at harvest on survival (not-gaping), total microbial loads, and changes in sensory character. Harvested sunray venus clams were tempered at 72°F for 6 to 10 hours prior to being transferred to refrigerated storage, which was maintained at a constant 45ºF. The numbers of gaping and dead sunray venus clams were determined visually on a daily basis. Microbial measures were based on standard aerobic plates counts conducted at 35°C (APC's - 35°C) utilizing official analytical procedures for seafood. Sensory measures were based on observations of mortalities and gaping, as well as development of off-flavors and other changes in attributes. The sensory assessment involved a team of three seafood experts located at the UF Aquatic Food Products Lab, who were experienced in sensory judgments for raw and cooked seafood. The sensory judgments were based on daily evaluations of the sunray venus clams using a 9-point hedonic scale that equates to 'Preferred' quality (1-3), 'Acceptable' quality (4-6), and 'Unacceptable' (7-9). 'Unacceptable' quality denoted the end of shelf life, while 'Acceptable' denoted the transition from 'Preferred' product quality. Like other clams, the sunray venus clam has a mild sea breeze odor and a briny, metallic flavor during the 'Preferred' stage. The end of shelf life is characterized by a disappearance of the ocean-like odors, and development of the typical odors and flavors that denote spoilage, such as strong fishy, wet dog, and bitterness.

Results of these assessments indicate that sunray venus clam shelf life was shorter during the summer (eight days post-harvest, 86-92%); whereas the shelf life of clams harvested in the winter was 21days with survivals ranging from 90-98%. During the shelf life assessment in the summer, sensory ratings were also determined for raw meats of the sunray venus clam. Microbial measures showed that end of the shelf life was mainly due to presence of off-flavors and off-odors (wet dog, bitter, putrid) rather than of high bacterial counts.

Sunray venus clams have the tendency to gape or open, more than hard clams, in the first few days of storage. To reduce gaping, sunray venus clams should be tightly packed in plastic mesh bags when in refrigerated storage. Sunray venus clams also differ from hard clams in that they have the tendency to remain closed when approaching mortality. Most clam species, including hard clams, typically gape or open when they become weak or die during storage. Therefore, it is recommended that retailers conduct a daily sensory evaluation of sunray venus clams nearing the shelf life expiration date (7 days after harvest in the summer and 19 days after harvest in the winter) to ensure the product is suitable for consumption. Also, the sunray venus clam should have a "best by date" on the tag of each product sold, just like eggs, produce, and other perishable foods sold in the United States.

Nutritional Profile

Sunray venus clams are a low-fat source of protein. A single 3-ounce (85 g) serving of sunray venus clams (18 to 20 cooked clams) provides approximately 9 g of protein. The low fat content (≤1%) is composed primarily of polyunsaturated fat (68%, with 50% omega-3 fatty acids) and the remainder (32%) as saturated fat. The level of cholesterol in sunray venus clams is about 25 mg per 85 g serving. This level is low when compared to fish, shellfish, and other foods, such as pork, eggs, chicken, and cheese. A complete nutritional profile for cultured sunray venus clams was determined at the UF Aquatic Food Products Lab by analyzing triplicate pooled groups of sunray venus clams for the required nutrients by the Nutrition Labeling and Education Act (Figure 8).

Nutrition Facts

Serving Size 3 oz (85g)
Servings Per Container

Amount Per Serving

Calories 50	Calories from Fat 10
	% Daily Value*
Total Fat 1g	**2%**
Saturated Fat 0g	**0%**
Trans Fat 0g	
Cholesterol 25mg	**8%**
Sodium 360mg	**15%**
Total Carbohydrate 2g	**1%**
Dietary Fiber 0g	**0%**
Sugars 0g	
Protein 9g	

Vitamin A 10% • Vitamin C 4%
Calcium 10% • Iron 40%
Vitamin B12 45% • Zinc 6%
Copper 4%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Figure 8. Nutrition Facts Panel for a 3-ounce serving (85 g, 18 to 20 clams) of cooked sunray venus clams.

The most important nutritional feature of the sunray venus clam is that a single 3-ounce (85 g) serving provides a good complement of minerals and vitamins. A 3-ounce serving size of cooked sunray venus clams also provides:

- 45% of the daily requirement of Vitamin B12. This vitamin is necessary for the formation of red blood cells and the utilization of protein.
- 10% of the daily requirement of Vitamin A and 4% of the daily requirement of Vitamin C. Vitamin A plays an important role in vision, in the growth and cellular proliferation as well as in the integrity of the immune system. Vitamin C is an important antioxidant.
- 40% of the daily requirement of Iron. Iron is essential in providing oxygen to the body. Iron is known as the 'hard to get' mineral, since only 6 mg of iron is absorbed per 1000

calories consumed. With clams, consumers receive a high percentage of iron without having to consume a lot of calories.

- 4% of the daily requirement of Zinc and 6% of the daily requirement of Copper. Zinc is required for growth, wound healing, sense of taste, and normal sexual maturation. Copper is essential for the proper utilization of iron in the body.
- 10% of the daily requirement of Calcium. This mineral is required for the ongoing processes of bone growth and development of teeth.

The Sodium content of mollusks, such as clams and oysters, can range from undetectable to as high as 600 mg/100 g (Sullivan and Otwell, 1992). The level depends on the salinity of the water within the growing areas. Sunray venus clams have an average sodium content of 360 mg per 100 grams.

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